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ABSTRACT

This study was conducted to identify bioethical topics of possible interest for a high school science curriculum, focusing on advantages and disadvantages of bioethical education and emphasizing the procedure to incorporate bioethics instruction into the secondary school science curriculum. Researched material is presented as an annotated bibliography, divided into three major sections. Annotations in the first section focus on current scientific issues concerned with social ethics. These include genetic engineering; recombinant DNA; cloning; artificial insemination/sperm banks; in-vitro fertilization; surrogate motherhood; population control; living, aging, dying, and human experimentation; environmental/energy issues; and phenylketonuria screening. Annotations in the second section focus on arguments (both pro and con) concerning bioethical education. Educational needs of teachers as well as an analysis of the treatment of bioethical issues in high school textbooks are addressed. Provided in the final area are annotations dealing with the methodology of incorporating bioethics into the science curriculum. In addition, innovative teaching techniques are identified. Among the results of the literature survey were findings that the majority of science educators favored teaching bioethical issues, although the rationale for teaching same varied and that preparation for future decision-making skills was seen as an important argument for educating students about values and bioethics. (JN)

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An Annotated Bibliography of Teaching Bioethics in the Public Secondary School

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BACKGROUND

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RATIONALE: The study of bioethics was selected largely because it is an area of scientific knowledge that has been neglected in the high school classrooms. Even in the small town of Bremen, Indiana, the media has forced students into an awareness of the personal and social problems created by the application of biological knowledge. Students have raised questions and teachers at Bremen High School have pondered their responses. This research in the area of ethics and social values in science has better prepared the author to deal more effectively with the issues of society in science courses at the high school level. The research has indirectly provided Bremen High School science students with more insight into responsible decisionmaking.

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INTRODUCTION

Science seems to influence every aspect of human life. Examples of the importance of science and technology for the production of food, water, shelter, clothing, medicines, transportation, and various sources of energy are universal.

Bioethical questions are becoming increasingly frequent following the recent advances in biology and in medical technology that have been made (Lewin:199-203). Topics such as genetic engineering, population control, and energy problems are receiving more attention from the news media which results in an increasing concern from society. Although science educators feel confident about their ability to teach classical science (Mertens, Hendrix, and Henriksen:161-165), the teacher of biology is often not equipped to handle the teaching of social and ethical concerns (Flint:719). Many biology textbooks approved for the classroom also deal inadequately with current bioethical issues (Boschman, Hendrix, and Mertens:13-20).

Bioethics is considered by science educators to be one of the most significant, yet most controversial of ideas in their discipline. Some educators argue that there is a need to get back to the basics of science (Berkheimer and McLeod:38-39) and preserve the integrity of science education by keeping the social sciences separate from the laboratory sciences (Moyer:380-381). Others maintain the argument that the teaching of the biological sciences in schools was much simpler a quarter-of-a-century ago than it is today (Carter:478) and biology instruction should provide students with experiences that will give them insight into some of the ethical issues they will face in the future (Barman and Rusch:1978a, 3).

Bioethics is an area of interdisciplinary studies whose focus depends on the kinds of issues examined and the nature of ethical inquiry (Reich: introduction, p. 19). The interdisciplinary approach to the teaching of bioethics is receiving much attention by educators. Teachers' attitudes toward interdisciplinary teaching seem to be favorable (Glenn and Gennaro:458).

Many innovative techniques and models for the teaching of bioethics are beginning to emerge in the area of secondary education. The Indiana State Teachers Association offers instructional conferences for high school teachers in the area of bioethics (see Appendix A; p. 45). Several national organizations offer information on academic programs in bioethics and related fields (see Appendix B; p. 46). Universities are conducting studies to determine the needs of secondary school students in the area of bioethics (Mertens: 18-24). However, the quantity and quality of science education for all people is not now commensurate with the status of science and technology. Educators must strive to insure appropriate science education for all citizens.

STATEMENT OF PROBLEM AND PURPOSE OF STUDY

As society has grown more complex, apprehension regarding the changes wrought by science, has created confusion. Tremendous advances have been made in the biological sciences in the last several decades, and the knowledge gained through biological advances have seemed only to add to the frustration. The cultural norms that had worked in the past when life had seemed much simpler, no longer provide guidance on many contemporary issues. The social values that are being drastically altered by biomedical advances range from developments that today are commonly accepted, such as the birth control pill, to newer techniques, such as the manipulation of human genetic material.

This study was conducted to identify bioethical topics of possible interest for a high school science curriculum. This paper deals specifically with the advantages and disadvantages of bioethical education and emphasized the procedure to incorporate the teaching of bioethics into the secondary school science curriculum. The information and recommendations provided to educators by this study is intended to improve science curricula in public secondary schools.

ORGANIZATION OF THE STUDY

The researched material was divided into three major categories. Some of the research overlapped, but the main ideas were categorized into the area which seemed most appropriate.

Current scientific issues concerned with social ethics were examined in the first part of the study. Issues such as recombinant-DNA, population control, and in-vitro fertilization were discussed in this section of the paper.

The second major category reviewed the arguments concerning bioethical education. The educational needs of teachers were discussed as well as an analysis of the treatment of bioethical issues in high school textbooks.

The final section of the study dealt with the methodology of incorporating bioethics in the science curriculum. Innovative techniques for teaching bioethics were identified.

The annotations were arranged alphabetically within each sub-category. Each sub-category was arranged within each of the three major categories of the study according to the logical development of the argument.

LIMITATION OF THE STUDY

Due to the recent move of The Society for Health and Human Values from the office in Philadelphia to the present location in McLean, Virginia, requests for information and/or publication materials were not received. Most of the information previously distributed by the organization had either not as yet been transferred to the new office or was being reprinted and was not available in time to be included in this research.

Time spent on research was limited by the semester deadline placed on its completion. The nature of bioethics provided unlimited scope when dealing with potential topics of interest in the science curriculum. However, the emergence of bioethics as a field of study is a contemporary phenomenon and much statistical research conducted in the area of bioethical education has yet to be made.

In a field as fast growing as bioethics, obsolescence of material was a problem that was difficult to avoid. The research attempted to summarize the current state of knowledge in bioethics within the last five years. The research was also forced to deal with the problem of bias. Since the paper involved the study of ethics and values, the presumption that biases and ideaologies might insinuate themselves was possible.

DEFINITION OF TERMS

Abortion--"to terminate pregnancy before term," (Webster:3).

Artificial Insemination--"introduction of semen into the uterus or oviduct by other than natural means," (Webster:64).

Bacterium--"unicellular microorganism which contains a single very large DNA molecule per cell," (Jackson and Stich:337).

Bioethics--"The systematic study of human conduct in the area of the life sciences and health care, insofar as this conduct is examined in the light of moral values and principles," (Reich:introduction 19).

Clone--"a group of genetically identical cells or organisms all descended from a single common ancestral cell," (King:60).

DNA--(deoxyribonucleic acid) "any of the various nucleic acids that are . . . the molecular basis of heredity," (Webster:335).

Dogmatism--"a viewpoint or system of ideas based on insufficiently examined premises," (Webster:337).

Embryo--"an organism in early stages of development; the developing human is designated as an embryo up to the beginning of the third month of pregnancy," (King:98).

Eugenics--"the improvement of humanity by altering its genetic composition by encouraging breeding of those presumed to have desirable genes (positive eugenics), and discouraging breeding of those presumed to have undesirable genes (negative eugenics)," (King:104).

Euthanasia--"the act or practice of killing individuals who are hopelessly sick or injured for reasons of mercy," (Webster:395).

Fertilization--"the union of two gametes (sperm and egg)," (King:110).

Gene--"the hereditary unit, containing DNA, that occupies a fixed chromosomal locus," (Gray:119).

Gene Pool--"the whole body of genes in an interbreeding population," (Webster:477).

Genetic Counseling--"providing heredity information to prospective parents before a child is conceived," (Reich:355).

Genetic Engineering--"different approaches to genetic manipulation, such as (1) a sexual reproduction achieved by cultivating cells from a donor whose genetic characteristics it is desired to perpetuate; (2) introduction into an organism of genetic material from another species; (3) modification of the genes by chemical treatment or by other laboratory precedures," (Reich:549).

Genetics--"a branch of biology that deals with the heredity and variation of organisms," (Webster:478).

Hybrid--"an offspring resulting from the union of two different forms," (Gray:262).

Informed Consent--"requirement that the patient voluntarily request treatment only after consequences are explained," (Reich:275).

Insulin--"a hormone secreted by the pancreas which is active in the control of carbohydrate metabolism." (Gray:270).

Interdisciplinary--"involving two or more academic, scientific, or artistic disciplines," (Webster:602).

In-vitro--"designating biological processes made to occur experimentaliy in isolation from the whole organism," (King:153).

Neurotransmitter--"a substance that transmits nerve impulses," (Webster:772).

Phenylketonuria (PKU)--"a hereditary metabolic disease in man," (King:222).

Psychosurgery--"brain surgery employed in treating psychic symptoms," (Webster:931).

Recombinant-DNA--"DNA molecules of different origin that have been joined together by biochemical techniques to make a single molecule," (Jackson and Stich:341).

Scientific Literacy--"not having only knowledge of the concepts, systems and processes of science, but also having the ability to learn what science one needs in order to apply it to relevant life situations," (Moyer:380).

Sperm Banking--"the freezing and preservation of sperm at low temperatures," (Reich:1446).

Surrogate--a person appointed to act in place of another," (Webster:1173).

Test-Tube Baby--"life that results from in-vitro fertilization," (Reich:1460).

ANNOTATIONS

BIOETHICAL TOPICS OF POSSIBLE INTEREST IN SCIENCE CURRICULUMS

Genetic Engineering

Goodfield, June, Playing God, Harper and Row, New York, 1979, 218 pp.

Goodfield discussed genetic engineering and the manipulation of life. She documented how scientists have fertilized a human embryo in a test tube, manufactured human insulin with a bacterium, synthasized a hormone produced by the brain to kill pain, fused a cell of a human with that of a tabacco plant, and made hybrid cells between a human and a monkey. According to the author, genetic research has raised many new issues that society needs to be informed of. Goodfield also provided insight into the problems of how and why rules are made in society and how laws are developed, outmoded, or extended.

Hilton, Bruce, Ethical Issues in Human Genetics, Plenum Press, New York, 1973, 415 pp.

This book was based on the proceedings of a Symposium sponsored by the Institute of Society, Ethics and the Life Sciences on October 10-14, 1971. The book first summarized the scientific knowledge which forms the basis of genetic counseling. The significance and meaning of genetic disease was then discussed from the perspectives of the individual patient and that of population groups. The ethical aspect led directly into the problem of the right to life and to a consideration of standards for this right. These discussions set the background for direct consideration of the existing legal situation, of privacy in genetic counseling, and the question of who decides to apply the available techniques. In conclusion, public policy with respect to control of applications of genetic knowledge was considered.

Lewin, Leonard C., "Bioethical Questions: Who Lives, Who Dies, and Who Decides?," Harpers 257:21-29, August, 1978.

Lewin stated that bioethical questions are being answered every day in response to circumstances. Bioethical decisions that must be made are becoming increasingly frequent following the advances in biology and in medical technology that have marked the last decades.

The author described several major areas in which bioethical questions are being examined: (1) the allocation of resources, (2) genetic screening, (3) experimentation, (4) death and dying, (5) population control, and (6) organ transplants. In conclusion Leonard emphasized "the questions won't get any easier."

Restak, Richard M., Pre-Meditated Man, The Viking Press, New York, 1975, 170 pp.

Restak divided the book into three parts. Part One, "Psychosurgery and the Cult Behavior Control," dealt with the appropriateness of behavior-control technology in a free society. Part Two, "Genetic Engineering: Opportunity or Trap?" examined in vitro fertilization and the test-tube baby controversy. Part three, "The Animal of Necessity," explored the problems raised by human experimentation. Restak concluded that the issues were not so much those of knowledge as they were of power. According to the author society should not allow decisions that will affect the most intimate aspects of life to be made by biotechnologic specialists.

Wilson, Miriam G., "More Parents-to-Be Seek Genetic Counseling," USA Today 110:8, April, 1981.

Wilson noted that increasing numbers of prospective parents were seeking genetic counseling in the past decade. According to Wilson, in every 100 live births, three or four babies were likely to be born with some defect. Wilson found that decision making was hardest for couples who were accustomed to an authoritarian model of medicine and for couples who had conflicting personal or religious views about ethical topics. In conclusion, the author predicted that increasing numbers of private-practice physicians will be offering genetic counseling on a routine basis.

Recombinant-DNA

"Creating New Forms of Life--Blessing or Curse?," U.S. News and World Report 82:80-81, April 11, 1977.

The article explored the controversial research in the area of recombinant-DNA. Possible benefits from current research were listed as well as concerns for society's safety. Many scientists have been unable to agree on the magnitude of possible risks and benefits in recombinant-DNA research. The public debates about continuing experiments involving recombinant-DNA are almost certain to continue.

Jackson, David A. and Stich, Stephen P., The Recombinant-DNA Debate, Prentice-Hall, Inc., Englewood Cliffs, 1979, 334 pp.

This book presented the views of philosophers, lawyers, sociologists, political scientists, and others on the subject of whether and how recombinant-DNA techniques should be employed. A scientific background was provided so that the reader without technical training could understand the methodology of recombinant-DNA research. Essays were also assembled by leading scientific opponents and defenders of recombinant-DNA research. A critical view at the logic (or lack of logic) in the arguments that dominated concluded the book. The authors suggested that the reader take a personal stand on the issues.

Marx, Jean L., "More Progress on Gene Transfer," Science 213:996-997, August, 1981.

Marx described several experiments in which researchers are attempting to introduce functional genes into a living animal. He reported that recombinant-DNA technology has made it possible to prepare purified genes in large enough quantities for injection into recently fertilized eggs. Marx stated that scientists would ultimately like to produce strains of animals that carry foreign genes in their germ cells and he suggested that the goal may soon be achieved.

Cloning

Fried, George H., "Cloning--The Promise and the Threat," USA Today 108:58-60, September, 1979.

Fried explored the history of cloning and explained the laboratory procedure involved with cloning. Although cloning has not been demonstrated in organisms more complex than frogs, opposition to cloning has been generated by the possibility that the cloning of mice, rats, and even humans may soon be accomplished. The author discussed both the benefits to society and the concerns of society regarding continuation of cloning research. Fried argued that to ban research in this area would not only represent an abridgement of scientific freedom, but would rob future generations of an opportunity to learn more about genetic control.

Artifical Insemination and Sperm Banks

Andrews, Lori B., "Inside the Genius Farm," Parents 55:80-84, October, 1980.

Andrews interviewed Robert Graham concerning Graham's plan to improve the quality of the human gene pool by using an artificial insemination by donor (AID) technique. Graham had plans to collect the sperm of Nobel Prize-winning scientists and use the sperm to impregnate females that were members of Mensa, an international society of people who were in the upper 2% of the population according to certain intelligence tests.

Andrews also asked other scientists to comment on Graham's proposal. The author found the eugenic proposals vary as to whether they use violence or economic incentives and whether they encourage "qualified" people to bear children or stop those "less qualified" from parenting.

Stossel, John, "One Answer to Childlessness--Artificial Insemination," Science Digest 88:20-23, March, 1980.

Stossel examined the ethical issue of artificial insemination. He interviewed couples about their motives involved in having an artificial inseminated child. The procedure of artificial insemination was also described by the author. Legal issues concerning artificial insemination and sperm banks were examined in the article and it was noted that no federal laws spell out the rights of artificially inseminated children. Children conceived by artificial insemination usually were not told and Stossel found that parents were very secretive about how the child was conceived.

In-Vitro Fertilization

Kieffer, George H., "IVF--In-Vitro Fertilization," The American Biology Teacher 42:211-218, April, 1980.

This author described the laboratory method for in-vitro fertilization (IVF), the benefits and risks associated with IVF, and the moral and ethical implications of IVF. Kieffer examined a few of the arguments on both sides of the IVF controversy. An important issue in the earlier stages of the debate was the question of safety. But the success of the "test-tube babies" and the positive results of numerous animal experiments had done much to remove this question from ethical consideration. Kieffer concluded by noting that, according to a 1978 Gallup poll, the majority of Americans approve in-vitro fertilization.

"To Fool (Or Not) With Mother Nature," Time 112:69, July 31, 1978.

The article noted that some theologians condemned in-vitro fertilization because "it puts the moment of creation outside the body into a mechanical environment." Others, like Rabbi Siegel of Manhattan's Jewish Theological Seminary, debated that "when nature does not permit conception, it is desirable to try to outwit nature." The article quoted theologians from different religions on the subject of in-vitro fertilization. The conclusion was that ethical questions raised by scientific advances in procreation are becoming more urgent as new techniques are explored and developed.

"Yes to Test Tube Babies," Time 113:89, April 2, 1979.

This article stated that the Ethics Advisory Board of the Department of Health, Education and Welfare has given in-vitro fertilization (IVF) research approval to continue. The decision was made only after hearings in eleven cities, where testimony was taken on the moral issues from 197 witnesses--ordinary citizens as well as noted scientists and clergymen. The article noted four safeguards that the board recommended as in-vitro research proceeded. Also recognized was the fact that Catholicism has apposed IVF because of Pope Pius XII's arguments against all unnatural methods of conception.

Surrogate Motherhood

Markoutsas, Elaine, "Women Who Have Babies for Other Women," Good Housekeeping 192:96-104, April, 1981.

This article presented several examples of publicized surrogate motherhood in the United States. Markoutsas stated that no one knows exactly how many women have served as modern day surrogates. However, it was also noted that advertisements seeking surrogates are becoming more common in classified sections in newspapers in various parts of the country. After interviewing several families involved with surrogate motherhood, Markoutsas concluded that motives varied. The author acknowledged the idea that in a relatively short time surrogate motherhood may become socially acceptable.

Seligmann, Jean and Curry, Robyne, "Pregnancy by Proxy," Newsweek 94:72, July 7, 1980.

The authors stated that doctors and lawyers are beginning to cooperate to bring together would-be parents and fertile women willing to have children for them. An example was given of a doctor in Kentucky who used a computer to match his clients.

The article also reviewed the legal and practical problems posed by surrogate motherhood. It was also noted that most legal experts agreed that the contracts drawn up between surrogates and infertile couples would carry little weight in a court of law.

Population Control

Culliton, Barbara J., "China's New Birth Policy: One Baby is Enough," Science 206:429, October, 1979.

Culliton reported that China is trying to reduce the birth rate in their country to 1% by 1985. The government of China has regulations that will provide rewards to those who follow them and punish those who insist on too many babies.

The article stated that in China contraceptives of all kinds are readily available and free. Couples in China are instructed not to marry until the woman is at least 23 and the man 25 years old. An only child's medical care would be free and the parents of a one-child family would be rewarded when they retire with a larger pension. The author did not state whether or not the people of China were accepting the new family planning regulations.

Stern, Zev, "Population Control and Scientific Ethics," USA Today 107:30-32, September, 1978.

Stern stated that since the methods of science deal only with the physical universe, science can have nothing to say about moral values. Science can provide technologies to manipulate the population of the world, but value judgments regarding the technologies must be made by society as a whole. The author noted that population size is spontaneously leveling off in developed countries and might be starting to level off in developing countries as well. Stern argued that, if there is a population problem, it has a technical solution and "does not require shedding our concepts of right and wrong or our definition of freedom."

Living, Aging, Dying, and Human Experimentation

Bylinsky, Gene, "Science is On the Trail of the Fountain of Youth," Fortune 94:134-140, July, 1976.

The author investigated the current research attempts being made to increase the intrinsic life span of the human species. Bylinsky found that researchers involved in experiments on aging have already demonstrated that the lives of laboratory rats can be extended. The life spans of tropical fish have been doubled by lowering the water temperature, which slows down development and aging. One researcher showed that there is a loss of dopamine, one of the brain's neurotransmitters, in aging mice. Another researcher was in the process of locating an "aging" hormone, which he thinks is released by the pituitary gland shortly after puberty. Bylinsky was convinced that soon experiments would involve humans, rather than laboratory animals.

Culliton, Barbara J., "Helping the Dying Die: Two Harvard Hospitals Go Public With Policies," Science 198:1105-1106, September, 1976.

The article defined the formal guidelines for the care of those about to die which were adopted by two hospitals in Boston. The advantages and disadvantages of having such a policy on passive euthanasia were discussed in the article. The author acknowledged that a concensus on euthanasia will probably never be reached. However, Culliton stated that a more flexible attitude toward passive euthanasia would provide the individual with the freedom to make a choice on the issue.

Isaacson, Walter, "The Battle over Abortion," Time 115:20-28, April 6, 1981.

Isaacson stated that abortion was the most emotional issue of morality that faced the nation in the past decade. On one side of the issue were those who argued that abortion was the murder of an unborn person and should be outlawed. Others contended that abortion was a woman's right.

The author noted that national polls indicated that 60% of Americans approved of the Supreme Court decision which legalized abortion. However, a National Opinion Research Center survey showed that more than 80% favored abortions in cases of rape and incest or when pregnancy was a threat to a woman's life. But only about 40% favored abortions for lesser reasons.

Sun, Marjorie, "Panel Asks When Is a Person Dead?," Science 209:669-670, August, 1980.

The results of an investigation on the definition of death were stated. The President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research could not reach a decision in an effort to adopt a uniform definition of death for all states. At the time of this article twenty-five states had laws that defined death as the "irreversible cessation of total brain function." The remaining twenty-five states equated heart and respiratory failure to death. The physicians who testified before the commission all agreed that irreversible cessation of total brain function was equivalent to death. Some theologians agreed with the physicians, but others argued that heart and breathing failure were the prerequisites for death to be declared.

London, Perry, "Experiments on Humans: Where to Draw the Line," Psychology Today 11:20-23, November, 1977.

London reviewed some examples of deceptive research on humans that had been done in the past. He attempted to define the principle of informed consent involving scientific research. He also expressed concern that biomedical research has not always followed the informal consent principle with its human subjects. London acknowledged that some deceptive research will have to be done in the future. Society must define where the "line needs to be drawn" on human experimentation.

Environmental and Energy Issues

Allan, Rodney F. and Laltart, David E., "Environmental/Energy Education: An Ethical Perspective," The American Biology Teacher 41:349-353, September, 1979.

The authors expressed concern about environmental and energy educational objectives in the public schools. They argued that the goal of energy education should "not be simply to have people turn off lights." According to the authors, much of environmental/energy education has been trying to communicate "good beliefs and values" for others to adopt for "their own good." The authors found that the traditional method of teaching kept individuals dependent upon others' values, rather than enabling individuals to develop their own commitments.

The authors identified in the article several objectives that need to be incorporated into the teaching of environmental and energy ethical problems.

Phenylketonuria Screening

Mertens, Thomas R. and Hendrix, Jon R., "PKU Screening: Issues and Dilemmas," The Science Teacher 45:26-27, February, 1978.

This article was one of several case studies developed by professors Mertens and Hendrix to bring controversial issues to the attention of their students. The phenylketonuria (PKU) screening case study has been used as a values-clarifying teaching strategy for students of human genetics and bioethics. Although fictitious, the story's facts were well documented to parallel real-life situations. The case study dealt with biological facts, but emphasized that data from other sources (such as economics, theology, philosophy, sociology, and psychology) would be necessary for wise decision making.

PROS AND CONS OF BIOETHICAL EDUCATION

Arguments in Favor of Bioethical Education

Barman Charles R., and Rusch, John Jay, "A Case for Bioethics in the Secondary Curriculum," School Science and Mathematics 78:3-8, January, 1978.

The authors proposed that biology instructors put a personal knowledge dimension into their curriculum. Students should be encouraged to actively deal with, reflect upon, and reach their own decisions on issues which have both biological and ethical decision-making components. Biology instruction should provide students with experiences that will give them insight into some of the bioethical issues they will face in the future. According to the authors, a useful methodology to achieve this purpose is values clarification. This technique provides students with a means to examine their own beliefs about issues that are presently of concern to society. Two examples of values clarification lessons dealing with bioethical issues are given at the end of this article.

Biological Sciences Curriculum Study, "Guidelines for Educational Priorities and Curricular Innovations in the Areas of Human and Medical Genetics," The Biological Sciences Curriculum Study Journal 1:19-29, February, 1978.

This study offered guidelines for development of an informed citizenry capable of making decisions concerning reproduction and genetic health. Three of the eleven guidelines were especially pertinent to public school education. Guideline I stated that education in human genetics should begin in elementary school and should be interdisciplinary. Guideline II stressed that educational programs in human and medical genetics must not avoid the controversial issues. And Guideline IV emphasized that "whatever we expect the general public to know about human genetics should be taught as a part of the high school biology curriculum."

Kelsh, Dennis J., "Human Values and Introductory Science," Improving College and University Teaching 29:150, Fall, 1981.

Kelsh argued that the strongest rationale for treating science/society issues in the science course comes from the knowledge that these issues will probably be dealt with less sympathetically in philosophy and social science courses. He cited examples of negative and pessimistic assessments of science and technology as shapers of society. The author noted that the "gloom and doom" advocates are unrealistic in suggesting that society can abandon technology on which we now depend.

Kelsh acknowledged that students should also learn that science and technology don't have answers for everything. Students need to learn that science is not ethically neutral in its applications and that issues of science are almost always subject to a variety of legitimate viewpoints and perspectives.

Kieffer, George H., "Futures Planning: Biology, Society, and Ethical Education," The Science Teacher 42:10-12, October, 1975.

Kieffer suggested changing the emphasis in the biology classroom from the cognitive domain to the affective domain. He stated that science teaching needs to have a "humanistic direction" introduced. Kieffer also noted that a "new biology" will be needed for all students at all grade levels. The elementary grades are not, according to the author, too early to begin development of skills for value analysis. Finally, the author suggested that teachers challenge students with unresolved ethical issues and avoid final conclusions, dogmatism, and teacher bias.

Kieffer, George H., "Should Bioethics Be Taught?," The American Biology Teacher 42:110-113, February, 1980.

Kieffer argued that bioethics must be taught, and with enthusiasm. Although society consists of many religious and ethnic groups and has no unanimously prescribed set of values, Kieffer stated that bioethical issues must be dealt with in high schools because: (1) they have a sense of urgency about them, (2) they are real life problems, and (3) they have long-range societal implication. The author added that teachers and students have the legal right to discuss controversial issues. Banning controversial questions (including bioethical issues) would violate the constitutional right to free speech and expression as established in the democracy of the United States.

Mertens, Thomas R., "You and Your Genetic Quotient: Part II," The Hoosier Science Teacher 6:18-24, September, 1980.

This study involved the results of a survey of 117 freshmen Honors College students at Ball State University. Only 46% of the students recalled studying about human genetic diseases in their high school biology classes. Added evidence that the students were deficient in their understanding of genetics came from a short pretest given them as they began a course in the biology department. Eight-five percent (85%) of the students recalled studying about mitosis and 93% had studied meiosis. From the results of the study Mertens concluded that high school biology instruction does little to familiarize students with the problems modern genetics has created for society. The results also suggested to the author that less emphasis should be placed on traditional subject matter and more emphasis on those areas where the discipline affects human well-being.

Yager, Robert E., Hofstein, Avi and Lunetta, Vincent N., "Science Education Attuned to Social Issues: Challenge for the '80's," The Science Teacher 48:12-14, December, 1981.

The authors assessed the current needs of science education by reviewing science education over the past twenty-five years. While the science taught in schools twenty years ago responded mainly to the present and the immediate past, today's science must be oriented to the future because of its potential in resolving serious societal problems.

The issue approach to science education was also stressed by the authors. Several examples of curricula having an issue-centered approach to science were given. The authors emphasized that a focus on social issues can directly involve students in decision making, problem solving, and cooperation with one another.

Arguments Against Bioethical Education

Berkheimer, Glenn D. and McLeod, Richard J., "Searching for Meaning in Science Education," The Science Teacher 46:38-39, April, 1979.

The authors of this article suggested that an explosion of new courses and topics has led to fragmentation of the science curriculum to such an extent that there is little coherence or structure either for students or teacher. Berkheimer and McLeod argued that science teachers need to get back to the basic disciplines of science and make sure that the students know the content of the disciplines before they attempt to apply it.

It was concluded that today's students are going to have to know more science and mathematics than in the past. An effort must be made, according to the authors, to develop science programs that meet the modern objectives of science education and restore its "true meaning."

Hickman, Faith M., "Education for Citizenship: Issues of Science and Society," The American Biology Teacher 44:358-367, September, 1982.

A questionnaire was sent to 733 biology teachers in Colorado. A total of 308 instruments were returned for analysis. The survey sought to determine (a) some of the issues of science and society that teachers choose to discuss (or not to discuss) with their students; (b) the amount of class time devoted to those issues; and (c) the factors which either inhibited or encouraged teachers toward greater emphasis on science/society issues in the general biology classroom.

The results of the survey showed about half of the respondents offered no instruction on topics such as air and water pollution standards, nuclear power, soil conservation, birth control, abortion, and human sexual behavior. More than half the respondents indicated they did not have time for issues of science and society and 32% believed that "the major topics of biology" were more important.

Moyer, Wayne A., "Arguments for Maintaining the Integrity of Science Education," The American Biology Teacher 43:380-381, October, 1981.

Moyer stated that the integrity of science and of science education must be preserved if science is to continue serving humanity. He pointed out that certain groups and individuals may perceive conflict between scientific knowledge and their personal beliefs. Christian Scientists, for example, might be offended by teaching of the germ theory of disease; Catholics might be offended by teaching reproductive physiology as it relates to birth control.

Moyer concluded that the first duty of the State in fostering science teaching within the schools under its control is to develop scientific literacy among future citizens. Therefore, the distinction between what is science and what is religion might be introduced into the social studies curriculum but not in the science curriculum.

Saperstein, Alvin M., "Does Good Science Teaching Contradict the Requirements of Modern Technology?," Journal of College Science Teaching 10:112, November, 1980.

Saperstein stated that the thinking patterns required of responsible technologists in today's world contradict the modes of thinking acquired via good science teaching. In the author's view, two sets of scientific technologists are needed. One set of scientific technologists would investigate phenomena scientifically and produce appropriate standards. The other set of technologists would religiously carry out the standards in spite of conflicting demands of economics, politics, society, and human frailties.

According to Saperstein, science teachers could help or hinder the realization of these two classes of technologists. It is the science teachers' obligation to initiate discussions with the students which will lead them, individually, to choose appropriate roles in the society of their future.

Teacher Qualifications for Teaching Bioethics

Blaga, Jeffrey J. and Cooney, Timothy M., "Teachers Need Help on Science-Related Social Issues," Phi Delta Kappan 62:400, January, 1981.

This article presented the results of survey in Iowa of 47 science and social studies specialists. Respondents were asked to identify the most pressing issues affecting United States society today. The questionnaire listed sixteen possibilities and encouraged respondents to add others. Bioethics ranked seventh in importance as perceived by the Iowa educators. The overwhelming majority of respondents (95%) agreed that teachers need help in understanding the scope and complexity of major issues. The same number said that teachers need help in developing strategies to teach youngsters about those issues.

Carter, Jack L., "The Anatomy of Controversy: Freedom and Responsibility for Teaching," BioScience 29:478-481, August, 1979.

Carter analyzed the science teaching revolution and the changing expectations of science education. He argued that the teaching of human genetics is no longer strictly an academic subject. He emphasized several controversial issues that have arisen and are continuing to arise out of the teaching of human genetics.

Carter also stated that neither science nor educational methods courses have prepared teachers of biology in the study of the humanities, and more specifically in the study of ethics. The author concluded that all science teachers need guidelines and protection if they are to teach the ethical issues that modern technology has provided humanity.

Flint, Franklin F., "Social Issues in the Biology Curriculum," BioScience 32:719, October, 1982.

Flint stated that the teacher of biology is often not equipped to handle the teaching of social and ethical concerns. Flint also noted that much of the available popular literature is not based on scientific truth and often the value of such literature is suspect due to the obvious biases of the authors. Therefore, Flint's article reviewed a series of papers written by experienced teachers and knowledgeable biologists. The various papers presented ideas, concepts, and approaches useful to the biology teacher. According to Flint, the papers would assist in bridging the gap between formal education and the understanding of the social issues in the biology curriculum.

Hendrix, Jon R., Mertens, Thomas R. and Sutton, Debra L., "Indiana Health Science Teachers: Their Human Genetics/Bioethics Educational Needs," The Hoosier Science Teacher 7:89-96, February, 1982.

From a list of 529 public school health science teachers obtained from the Indiana Department of Public Instruction, a random sample of 300 individuals was selected to receive a human genetics/bioethics needs assessment instrument. The teachers were surveyed to determine which, if any, of fifteen genetics-related topics they normally include in their health instruction. The teachers were also asked to react to sixteen different value-laden statements concerning the relationship of genetics to society.

The authors found that Indiana public school health science teachers have clearly delineated human genetics/bioethics educational needs. Since all public school students in Indiana are required to have instruction in health science, it is important that the human genetics/bioethics educational needs of the health science teachers be met.

Jungwirth, Ehud, "Some Biology/Social Science Interfaces and the Teaching of Biology," Journal of Biological Education 14:339-344, December, 1980.

This article presented a variety of examples of what Jungwirth termed "the interfaces of biology and the social sciences." The author argued that teachers' conscious priorities in selecting topics for teaching rarely include the biology/social science combination.

Teachers are usually unaware of the existence and implications of "hidden ideologies" in the curriculum. Jungwirth stressed the point that only by redirecting the education of teachers can teacher awareness and priorities be suitably altered.

Mertens, Thomas R. and Hendrix, Jon R., "A Survey of the Genetics Educational Needs of Indiana Secondary School Biology/Life Science Teachers," The Hoosier Science Teacher 4:5-12, September, 1978.

This study dealt with the data summarized from 194 questionnaires completed and returned by Indiana secondary school biology/life science teachers. Each teacher completing the questionnaire was asked to react to sixteen different value-laden statements concerning the interface of genetics and society. The relatively high percentage of teachers who held no opinion on some of the issues suggested to the authors that the teachers did not understand the issue or that the teachers had not sufficiently reflected on the issue to have an informed opinion. The existence of conflicting positions on many of the issues also suggested to the authors that it is important for teachers to clarify their own personal value stances.

Mertens, Thomas, R., Hendrix, Jon R. and Henriksen, Larry W., "Biology Teachers: Genetics Educational Needs and Related Value Stances," The Journal of Heredity 70:161-165, May-June, 1979.

This study was developed to reveal the genetics educational needs of inservice secondary school biology teachers. A questionnaire was distributed to a total of 1,000 teachers as follows: 250 in Alabama, 300 in Indiana, 250 in Massachusetts, and 200 in Oregon. A total of 542 completed questionnaires were returned. The data suggested to the authors that, although the teachers are confident of their ability to teach about classical and molecular genetics, they are much less knowledgeable of the recent developments in genetics that deal with society and ethical standards. The data further implied to the authors that if teachers are to deal effectively with current and controversial topics, they will need instruction not only in human and medical genetics, but also in the methodologies of teaching about controversial issues.

Textbook Analysis of Bioethical Issues

Boschmann, Hugo, Hendrix, Jon R. and Mertens, Thomas R., "Six State Adopted Biology Textbooks: Do They Raise Bioethical Issues?," The Hoosier Science Teacher 4:13-20, September, 1978.

The intent of this study was to examine the Indiana state adopted high school biology textbooks to determine what, if any, bioethical issues were presented. An examination of the data for six biology textbooks on the Indiana State Approved Biology Textbooks list revealed that not all biology textbooks approved for the classroom dealt adequately with bioethical issues. The issues that were treated most often by all textbooks were those that have been with us for some time. Among those were population, food and famine, evolution (although rarely evolution versus creation), pollution, and energy. The newer, more controversial issues--such as abortion, family planning, genetic screening and counseling, and recombinant-DNA--represented more complex questions and textbook authors shied away from these areas.

Levin, Florence S. and Lindbeck, Joy S., "An Analysis of Selected Biology Textbooks for the Treatment of Controversial Issues and Biosocial Problems, Journal of Research in Science Teaching 16:199-203, May, 1979.

The purpose of this study was to determine the coverage of controversial issues and biosocial problems by five selected biology textbooks. Eleven controversial issues and biosocial problems were employed as independent variables in this study. They were: Darwinian evolution, disease states, drugs, environment, human genetics, human reproduction, man--his place in nature, the origin of life, the population explosion, biological effects of radiation, and race--variation in man. The authors concluded from the investigation that textbooks differ considerably in their treatment of controversial issues and problems and that no one textbook gives adequate treatment of all the issues and problems.

INCORPORATION OF BIOETHICS IN THE SCIENCE CURRICULUM

Interdisciplinary Approach

Beisenherz, Paul C., "Putting Science and Society in Your Classroom," The American Biology Teacher 44:180-181+, March, 1982.

Beisenherz identified several procedures that would aid teachers in integrating society-oriented topics into their biology classrooms. The author stated that teachers will need to broaden their content background, diversify instructional techniques, and become more flexible and creative as social issues are integrated into the biology curricula. The author emphasized the importance of obtaining help in implementing goals of the biology curriculum. With the social issues approach, the librarian can become a vital source of information for the science teacher. Beisenherz argued that failure to use teachers in other disciplines within the biology curriculum would make the teaching of society-oriented topics much more difficult and would provide students with a more limited exposure to a particular topic.

Davis, William E. and Richter, Peyton E., "Integrating Science and Humanities--A Modular Approach," Journal of College Science Teaching 10:176-177, January, 1981.

The authors outlined an interdisciplinary project conducted by the faculty at Boston University's College of Basic Studies. Using a science course as the "vehicle," the project attempted to integrate science, humanities, and social science. The authors acknowledged that having two or more teachers jointly produce a course sometimes resulted in a "watering down," rather than a strengthening of two disciplines. However, most of the difficulties were avoided by using a modular approach and by implementing the integration at the lecture level. The modular approach allowed the instructors to select an area of natural overlap among the disciplines.

A formal evaluation of the effectiveness of the project was not made. The authors reported, however, that faculty and student responses were favorable.

Glenn, Allen D. and Gennaro, Eugene D., "Attitudes of Science and Social-Studies Teachers Toward Interdisciplinary Topics and Value Questions," School Science and Mathematics 81:451-458, October, 1981.

This study was designed to gather information about science and social-studies teachers' attitudes with respect to dealing with interdisciplinary topics and value issues in the classroom and to raise questions for further research. The data were from teachers in a large metropolitan district in Minnesota.

The authors found that teachers in science and social studies had an overall favorable attitude towards interdisciplinary teaching. Decided differences among the teachers, however, suggested that the movement toward effective teaching in this area will not be an easy one. Teachers in both content areas believed they had a knowledge of specific teaching strategies to deal with value issues. The authors concluded that more research is needed in the following areas: (1) teacher attitudes, (2) teacher behavior, (3) teacher knowledge, and (4) student outcomes.

Mertens, Thomas R. and Hendrix, Jon R., "Responsible Decisionmaking: A Tool For Developing Biological Literacy," The American Biology Teacher 44:148-152, March, 1982.

The authors described the events that led to the founding of the Human Genetics and Bioethics Education Laboratory at Ball State University. The laboratory has conducted needs assessment surveys in Indiana and published the results in several periodicals.

Mertens and Hendrix developed and tested a model for bioethical decisionmaking designed to enable students to clarify their own values rather than have their instructor's values imposed upon them. The model stressed examining alternative solutions to ethical problems and the consequences of those solutions. The authors stressed that biology teachers and those who teach the humanities must "merge their skills" in order for both to shed their discipline-oriented approach to teaching.

Singleton, Rivers and Brock, D. Heyward, "Teaching Bioethics from an Interdisciplinary Perspective," The American Biology Teacher 44:280-285, May, 1982.

This article described an experimental interdisciplinary workshop in bioethics for high school teachers conducted at the University of Delaware during the summer of 1980. The overall goal of the workshop was to reduce the lack of knowledge, training, and confidence both of science and humanities teachers to deal with bioethical issues by providing information, materials, and methods for classroom use. On the basis of evaluation questionnaires completed at the end of the workshop, these objectives were met. Two potential problems became apparent during the workshop: (1) the distinction between interdisciplinary teaching and team teaching, and (2) the lack of bioethics reading materials accessible to most secondary students.

Innovative Methods for Teaching Bioethics

Barman, Charles R., "Four Values Education Approaches for Science Teaching," The American Biology Teacher 42:152-156, March, 1980.

Barman described four values education approaches which may provide mechansisms for incorporating current values issues into the biology curriculum. The article focused on the main objectives of moral development, values clarification, action learning, and analysis. An example of how each instructional strategy can be used in science teaching was also provided. The author found that each of these approaches, if used in a non-judgmental manner, can allow students to examine their attitudes and beliefs freely. He also concluded that the four values education approaches can assist students in developing decision-making skills.

Barman, Charles R. and Rusch, John J., "Bioethics: A Rationale and a Model," The American Biology Teacher 40:85-90+, February, 1978.

The authors of this article argued that the best approach to teaching bioethical issues was to add a separate bioethics course to the curriculum rather than integrating bioethics into existing courses. General suggestions were offered for instructors who plan to add bioethics to the curriculum of their institution. It was stated that an important dimension of the development of a bioethics course was evaluation. The authors listed five student objectives which were recognized as being important components for assessing a bioethics course.

Bloom, Arthur and Constan, Phyllis, "The Quality of Life for the World's Population: A Unit on Bioethics," The American Biology Teacher 38:292-294, May, 1976.

The authors outlined a high school bioethics unit which was designed to give students an opportunity to analyze data, consider alternatives and consequences, hypothesize, formulate models, and make decisions. A combination of role-playing and values clarification strategies were used to achieve those objectives. The preliminary work for the unit was intended to prepare the students for a world conference in which they would participate as delegates. Prior to the conference Aldous Huxley's Brave New World and Paul Ehrlich's Population Bomb were assigned. Those two books provided a background for later, more specific readings in population control, food distribution, and genetic engineering. The authors concluded that the unit was successful in meeting the objectives of providing an interdisciplinary and value-clarifying experience for the students.

Bridger, James A., "The Teaching of Life-Line Ethics," The American Biology Teacher 39:242-243, April, 1977.

Bridger outlined several techniques intended to increase student knowledge and awareness of bioethical topics. He found that the concept of a "life-line" served as an effective way to initiate discussion on bioethical issues. The "life-line" technique simply categorizes bioethical areas into three categories: (1) conception, (2) birth, and (3) death. The author stated that this simple construction allowed most students to more critically analyze their opinions concerning bioethical topics.

Another method Bridger used with a high degree of success was the "scenario." This technique involved the presentation of a situation concerning one of the bioethical dilemmas and allowing the students to cast themselves in the roles indicated by the scenario.

Bybee, Rodger W., "Science Education for an Ecological Society." The American Biology Teacher 41:154-163, March, 1979.

Bybee reviewed the findings of a survey done by the National Assessment of Educational Progress on 1977. From the results of the survey he suggested new goals for sicence education and discussed the implications of those goals for curriculum and instruction. Bybee noted that many materials and ideas already exist to facilitate the change in science education and it is only a matter of coordinating the materials and bringing the materials to the attention of science teachers. The author also emphasized that effective models for initiating curriculum changes already exist and science teachers only need to think of modifying, coordinating, and using some existing ideas and programs.

Charlton, Ronald E., "Futuristics in Biology: Some Techniques," The American Biology Teacher 41:136-139, March, 1979.

Charlton suggested several inexpensive techniques that may be adapted and modified easily in the classroom to have students think about the future. Charlton argued that too much of teaching and learning is directed to the past, or, at best, the present.

The author listed and described four techniques that can be used in the biology classroom to educate for the future. The techniques were: (1) "the Delphi Game"--an intuitive method of organizing and sharing "expert" forecasts about the future, (2) a "cross-impact matrix" which allows students to assess the impact of several factors on each other as they interact, (3) a "future circle or decision tree"--methods used to call attention to alternatives, and (4) a scenario--a reflection of existing trends and their possible consequences.

Cusimano, Vincent J. and Halpern, Stephen, "Science Forum II: Bioethics," The American Biology Teacher 41:234-256, April, 1979.

This article analyzed the affective nature of bioethical issues, the role of the teacher in implementing programs, and specific guidelines for using the "science forum" technique for considering bioethical issues. A timetable for incorporating bioethical issues into an existing biology curriculum was also offered. The authors stressed the use of the "science forum" technique of summarizing a course whereby students would be given the opportunity to meet and discuss issues with other students, educators, parents, and medical and scientific professionals. According to the authors, the science forum underscored the need for communication among the many elements of society and gave students the opportunity to test their own values by communicating on an objective scientific level.

Hendrix, Jon R., Mertens, Thomas R. and Baumgartner, Randall S., "Individualizing Instruction Through Concept Assessment," The American Biology Teacher 43:246-253, May, 1981.

This article described the development of the Cognitive Biological Concept Assessment Instrument (CBCAI) by the authors. The functional goal of the CBCAI was to determine students' initial levels of understanding of bioethical terms and concepts so that instructors could be more effective in helping students attain desired concept levels. Three populations (high school students, college students, and high school teachers) were tested with the instrument. The authors found that biology teachers can derive two benefits from using the CBCAI: (1) teachers can use the information to concentrate instruction on identified needs areas, and (2) after retesting at the end of instruction, teachers can evaluate how successful they were in raising the students' concept levels for the specific terms used in the instrument.

Hiscoe, Helen B. and Ahl, Alwynelle S., "Teaching Human Reproduction--Scientific Facts and Social Issues," Journal of College Science Teaching 9:28-31, September, 1979.

The authors found that a search of the literature on sex education revealed that most human reproduction courses focused on psychological and personal aspects of sexuality. Hiscoe and Ahl argued that the teaching of social and ethical issues related to human reproduction should become a priority in every school's curriculum.

In this article a course called Social Aspects of Human Reproduction was described. The goals of the course along with the objectives of the course were detailed by the authors.

Hoskins, Betty B., "Sensitizing Introductory Biology Students to Bioethics Issues," The American Biology Teacher 41:151-3+, March, 1979.

Hoskins provided the method of introducing bioethical issues to introductory biology students at Worcester Polytechnic Institute in Worcester, Massachusetts. A description of laboratory and discussion exercises was offered that had the purpose of arousing student consciousness of bioethical issues. Examples of the impact of the exercises on students were also presented in the article.

Hoskins stated that laboratory exercises often raise ethical questions. She suggested some general and specific objectives in the affective domain for several experiments and demonstrated how student responses can help the instructor to gauge effectiveness in attaining those objectives.

Mitchell, John J., "The Use of Case Studies in Bioethics Courses," Journal of Nursing Education 20:31-36, November, 1981.

Mitchell identified nine specific benefits of a case study approach in bioethics courses. He also advocated an interdisciplinary approach to issue analysis because it provided the student with an opportunity to explore the moral significance of specific bioethical issues from different perspectives. The role of the course instructor was emphasized as being extremely important in the success of this approach to teaching decision-making skills. In conclusion, Mitchell stressed that case studies alone are not adequate for maturing the mind of a student. However, "when case studies are analyzed in concert with various methodological tools the results can be most rewarding."

Nalence, Eugene E., "Science--Society Mini-Courses Hit Home!," The Science Teacher 47:26-28, September, 1980.

Nalence related in this article how Marple Newton High School in Newton Square, Pennsylvania integrated science-based social issues into its curriculum. Several four week mini-courses were offered each semester which related science, technology, and social issues. Each mini-course consisted of a presentation of some contemporary problem, development of the scientific background required to analyze the problem, appropriate laboratory work, discussion of the non-technical aspects of the problem, and consideration of possible solutions to the problem. In analyzing possible solutions, special emphasis was given to the idea of finding the "better" answer rather than the "right" one.

Newgent, Gwen C., Tipton, Thomas J. and Brooks, David W., "Trigger Tapes: How to Pose Ethical Questions," Instructional Innovator 25:41-42, May, 1980.

These authors explained a unique method of promoting student awareness and interaction about value-based issues typically encountered in scientific fields. The "trigger tapes" were actually short films produced by the University of Nebraska Science Department to demonstrate the ethical and social dilemmas that can arise out of the work of scientists.

Extensive evaluation with students enrolled in three basic college science courses showed that students responded positively to programs presenting issues that were within the realm of their experience. Data revealed that 1½ to 2 minute films were long enough to present the dilemma. There was no correlation between how the students rated a program and the intructor's rating of the program's effectiveness in eliciting discussion. Evaluation confirmed that the tapes should be open-ended; dilemmas should be left unresolved.

Rosenthal, Dorothy B., "A 'Science and Society' Course for High School Students," The American Biology Teacher 41:336-340, September, 1979.

The author described some aspects of an experimental elective course for high school seniors. This article explained the rationale, course design, resource materials, and student responses which resulted from the "Science and Society" course. The interdisciplinary course was designed for the average citizen of the future. The author found that role-playing activities and simulations were among the best ways of interesting students in bioethical problems. The results of the experimental course suggested to the authors that more students could be reached, and earlier in their high school careers, by incorporating the material into appropriate science courses, rather than having a separate course for the teaching of bioethics.

Smith, Regina, "Bioethics in High School Studies," Momentum 11:10-11, December, 1980.

Smith outlined an innovative program initiated in Red Bank Catholic High School, Red Bank, New Jersey. A science club called B.R.I.M. (Biological Revolution and Its Implications on Man) was formed to involve and interest all student members in recent biomedical advances, together with their social and ethical implications. The club met weekly during an activity period. The key skill students were encouraged to develop was sensitive listening to one another. During one academic term, the club's record of resolved dilemmas included: (1) organ transplant, (2) kidney dialysis patient selection, (3) test tube babies, (4) fetal research, (5) human behavior control, and (6) eugenics.

Midway in the beginning year of the program, the teachers were asked to complete an evaluation form and give their reactions to the program. The teachers stated that they were comfortable and secure in their free presentation of alternatives to today's ciritical issues when they were knowledgeable of both the biological and ethical ramifications. They wanted the program to continue.

Steiner, Elizabeth and Hitchcock, Ruth, "Teaching Moral Criticism in the Sciences," Viewpoints in Teaching and Learning 56:63-73, Fall, 1980.

In reviewing educational programs in science, the authors found that each program could be grouped according to the approach to moral education utilized. Some programs used value clarification, others value analysis, and still others used moral reasoning. Since the authors found these three approaches inadequate, the moral criticism approach was developed.

The authors explained the moral criticism approach in science education. In this approach elements of criticism and moral reasoning were combined to delineate rational decision making. With the moral criticism approach one comes to conclusions about rightness or wrongness of actions relative to the use of scientific knowledge. The procedure outlines utilized relevant criteria for description, interpretation, and evaluation.

SUMMARY

Lewin asserted that bioethical questions are being answered everyday in response to circumstance and Restak contended that society should not allow questions that will affect the most intimate aspects of life to be made by biotechnological specialists. Wilson noted that increasing numbers of prospective parents were seeking genetic counseling. A major area of bioethical concern is genetic engineering and the manipulation of life, according to Goodfield and Hilton.

Marx described the progress of research involving recombinant-DNA while Jackson and Stich pointed out that many scientists have been unable to agree on the magnitude of possible risks and benefits in recombinant-DNA research. Fried disputed that to ban research in the area of cloning would rob future generations of an opportunity to learn more about genetic control.

Regarding eugenics, Andrews found that proposals by scientists varied as to whether violence or economic incentives were used and whether or not they should prevent certain people from having children. Stossel noted that no federal laws spelled out the rights of an artificially-inseminated child.

Kieffer stated that the majority of Americans approved of in-vitro fertilization; however, theologians from different religions could not agree on the subject of in-vitro fertilization. Markoutsas argued that surrogate motherhood may soon become socially acceptable. Seligmann and Curry added that doctors and lawyers are beginning to cooperate to unite would-be parents and women willing to have children.

Culliton outlined China's government regulations that provide rewards to those who follow the rules and punish those who have too many babies.

Stern countered by noting that population size is spontaneously leveling off in developed countries and might be starting to level off in developing countries as well. He argued that, if there is a population problem, it does not require that the concept of freedom be eliminated.

Isaacson stated that abortion was the most emotional issue of morality that faced the nation in the past decade while Culliton acknowledged that a concensus on euthanasia will undoubtedly never be reached. Sun reported that the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research could not reach a decision in an effort to adopt a uniform definition of death for all states. Society must define limitations on human experimentation, argued London. Researchers, according to Bylinsky, have already demonstrated that the lives of laboratory rats have surgically been extended. He was convinced that there would be experiments on humans in the near future.

Barman and Rusch argued in favor of teaching about bioethical issues in the secondary science curriculum. They contended that biology instruction should provide students with insight into some of the issues they will face in the future. Yager pointed out that, while the science taught in schools twenty years ago responded to the present and the past, today's science must be oriented to the future. Kelsh asserted that the strongest rationale for treating science/society issues in a science course comes from the knowledge that the issues would probably be dealt with less sympathetically in philosophy and social science courses. According to Kieffer, teachers and students have the legal right to discuss controversial issues. He also emphasized that the elementary grades are not too early to begin development of skills for value analysis. Mertens added statistical

evidence that indicated high school biology instruction did little to familiarize students with the problems that modern genetics has created for society. Finally, the argument in favor of the teaching of bioethics in the public secondary schools was supported by three guidelines offered by The Biological Sciences Curriculum Study.

Berkheimer and McLeod argued against bioethical education because an explosion of new courses and topics would lead to fragmentation of the science curriculum and reduce coherence or structure for both students and teachers. Moyer added that the distinction between what is science and what is religion might be introduced into the social studies curriculum but not the science curriculum. Hickman provided statistical evidence that indicated many science teachers did not have time to teach ethical issues of society and some believed that "the major topics of biology" were more important. Saperstein, however, conceded that, possibly, society needs two sets of scientific technologists--one which would investigate and produce standards and another which would religiously carry out the standards in spite of conflicting pressures of society.

Mertens, Hendrix, Henriksen, and Sutton provided statistical evidence that science and health teachers in Indiana demonstrated a need for instruction in the methodologies of teaching about controversial issues, especially in the areas of human and medical genetics. Blaga's study also showed that science teachers needed help in developing strategies to teach students about science-related social issues in Iowa. Flint stated that the biology teacher is often not equipped to handle the teaching of social and ethical concerns because of a lack of unbiased literature. Science teachers need guidelines and protection, added Carter, if they are to teach the ethical issues of

modern technology. Jungwirth pointed out that only by redirecting the education of teachers can teacher awareness of the biology/social science combination be altered.

Levin and Lindbeck concluded that science textbooks differed in their treatment of controversial issues and that no one textbook offered adequate treatment of all the issues and problems. According to Boschmann, Hendrix, and Mertens the issues that were treated most often by all textbooks were those issues that had existed for some time, rather than the newer, more controversial issues.

Mertens and Hendrix stressed that biology teachers and those who teach the humanities must combine their teaching skills to enable students to clarify their own values. Beisenherz agreed with Mertens and Hendrix by noting that the librarian can become a vital source of information for the science teacher. According to Glenn and Gennaro, teachers had an overall favorable attitude toward interdisciplinary teaching. However, Singleton and Brock found that teachers do not understand the distinction between interdisciplinary teaching and team teaching. Davis and Richter further acknowledged that having two or more teachers jointly produce a course sometimes resulted in a dilution, rather than a strengthening of the two disciplines. They recommended implementing the integration of separate disciplines at the lecture level.

Bybee discovered that many materials, ideas, and methods already exist for initiating curriculum changes and it is only a matter of bringing the materials to the attention of science teachers. Hoskins noted that the utilization of laboratory exercises was an effective method of introducing bioethical issues to a biology class. She offered examples of

laboratory exercises that often raised ethical questions. Bridger added that the concept of a "life-line" served as an effective way to initiate discussion on bioethical issues. Carlton described four techniques for educating the biology student for the future: (1) the "Delphi Game," (2) a "cross-impact matrix," (3) a "future circle" or "decision tree," and (4) a "scenario." According to Newgent, Tipton, and Brooks "trigger tapes" were a means of demonstrating the ethical and social dilemmas that could arise out of the work of scientists. The use of the "science forum" technique of summarizing a bioethical course was stressed by Cusimano and Helpern. They maintained that the science forum emphasized the need for communication among the many elements of society.

Mitchell identified the advantages of a "case study" approach in bioethics courses. He conceded, however, that case studies alone were not adequate for maturing the mind of a student. Value clarification, value analysis, and moral reasoning approaches to moral education were inadequate, according to Steiner and Hitchcock. They found that the moral criticism approach in science education was most effective for rational decision making.

Bloom and Constan outlined a high school bioethics unit which utilized a combination of role-playing and values-clarification strategies to achieve unit objectives while Hiscoe and Ahl described the objectives of a course entitled "Social Aspects of Human Reproduction." Smith detailed the objectives of a science club which was formed to involve and interest all student members in recent biomedical advances, together with their social and ethical implications. The students were enthusiastic about the club, which met only once a week.

Rosenthal found that more students could be reached, and earlier in their high school careers, by the incorporation of ethics into appropriate science courses, rather than having a separate course for the teaching of bioethics. Barman and Rusch, however, contended that the best approach to teaching bioethical issues was to add a separate bioethics course to the curriculum rather than integrating bioethics into existing courses. Nalence offered a compromise and described a successful program that offered several four-week, science-society minicourses at the secondary level. Finally, the development of the CBCAI, an evaluation instrument that could be used by teachers to evaluate students' concepts of bioethical terms, was described by Hendrix, Mertens, and Baumgartner.

CONCLUSIONS

Bioethics is a contemporary problem which is receiving an increasing amount of attention by science educators. The present and potential uses of scientific knowledge and technology are widely known. The issues have been frequently presented to the public by the mass media.

Many of the arguments concerning the ethical issues raised by new discoveries and ideas in biology may never be resolved. Scientists have not been able to agree on the magnitude of possible risks and benefits of recombinant-DNA, in-vitro fertilization, cloning, and human experimentation. Governments cannot reach a decision regarding population control, artificial insemination, euthanasia, or even a definition of death. Theologians argue about abortion, in-vitro fertilization, and surrogate motherhood. Society is confused and concerned about the destiny of humanity.

The research indicated that the majority of science educators were in favor of teaching bioethical issues in the secondary science curriculum. The rationale for teaching bioethics varied. Students demonstrated a need for instruction in the human genetics area of biology. Preparation for future decision-making skills was also seen as an important argument for educating young students about values and bioethics. It was also pointed out that teachers have a legal right to discuss controversial issues with students in the science classroom.

The arguments against bioethical education were not strong and few in number. Possible fragmentation of the science curriculum, lack of time to teach the issues, and the fact that classical biology should have priority were arguments against teaching bioethics in the secondary school curriculum.

There was strong evidence that science teachers have not been prepared adequately to teach bioethics, even though most of the teachers seemed to have confidence in their abilities to deal with the issues. Also, biology textbooks varied in their treatment of bioethical issues and most of them avoided the major controversial issues.

The teaching of bioethics requires interdisciplinary teaching of some type. Although there may be some drawbacks to interdisciplinary teaching, most teachers had a positive attitude about experimenting with the idea. Many innovative ideas and techniques were presented to aid science teachers in incorporating bioethics into the science curriculum. Although there was some question as to how bioethics should be placed in the curriculum, most of the research indicated it should be integrated in the regular biology class, rather than as a separate course offering.

The individual teacher of biology could choose several different approaches to introduce bioethics to high school students. Case-studies, laboratory experiments, role-playing, games, films (trigger tapes), guest speakers (forum), and library work were all techniques included in the methodology of teaching bioethics in the secondary schools. Many types of science/society courses have been implemented and evaluated. Most of the courses demonstrated considerable success and student enthusiasm.

There is always room for improvement in science education. The current goals of biology teaching need to be relevant to contemporary priorities. The teacher is the key to the successful implementation of a science program. Science educators must strive to insure appropriate science education for all citizens.

RECOMMENDATIONS

It is recommended that:

1. Biology teachers make a conscientious effort to expand the study of controversial issues beyond the limitations of the textbooks by the use of well-prepared supplementary materials on societal problems.
2. Science courses provide students with opportunities to develop skills in identifying science-based societal problems and in making decisions about their resolution.
3. Science education emphasize the future more than the past.

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Appendix A

McConnell, Susan and Shaul, Pam, "Why Bioethics," Indiana State Teachers Association Conference on Instruction, Indianapolis, Indiana, October 23, 1982.

The speakers addressed the subject of teaching bioethics in high school biology courses. A rationale for incorporating ethics teaching within the existing science curriculum was advocated. McConnell presented several case studies arising from the application of technology to bio-social problems such as: abortion, artificial insemination, surrogate mothers, test tube babies, genetic engineering, and genetic screening.

Shaul briefly described a summer seminar she attended at Ball State University that was funded by the National Science Foundation. The seminar provided high school biology teachers with information and ideas for emphasizing ethics teaching in the human genetics unit of general biology.

The speakers demonstrated the bioethical decision-making process that was used in their high school curriculum. The group attending the conference on instruction of bioethics was then divided into small groups and asked to work through the bioethical decision-making response sheet that McConnell and Shaul used within their biology classes. In conclusion, the speakers noted that the inclusion of bioethical topics increased student enthusiasm and participation in the general biology classes at Muncie High School.

Appendix B

Addresses for Additional Educational Information on Bioethics*

Bibliography of Bioethics
Gale Research Company
Book Tower
Detroit, MI 48226

Bibliography of Society, Ethics and the Life Sciences
The Institute of Society, Ethics and the Life Sciences
360 Broadway
Hastings-on-Hudson, NY 10706

Bioethics Digest
Information Planning Associates, Inc.
P.O. Box 1523
Rockville, MD 20850

Bioethicsline
Office of Inquiries and Publications Management
National Library of Medicine
8600 Rockville Pike
Bethesda, MD 20014

Ethics
University of Chicago Press
5801 Ellis Avenue
Chicago, IL 60637

Ethics in Science and Medicine
Maxwell House, Fairview Park
Elmsford, NY 10523

EVIST Resource Directory
Office of Science Education
American Association for the Advancement of Science
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036

Hastings Center Report
360 Broadway
Hastings-on-Hudson, NY 10706

Lancet
% Little, Brown and Company
34 Beacon Street
Boston, MA 02106

Linacre Quarterly
850 Elm Grove Road
Elm Grove, WI 53122

New Titles in Bioethics
Center for Bioethics Library
Kennedy Institute of Ethics
Georgetown University
Washington, D.C. 20057

Perspectives in Biology and Medicine
University of Chicago Press
5801 Ellis Avenue
Chicago, IL 60637

Science
American Association for the Advancement of Science
1515 Massachusetts Avenue, N.W.
Washington, D.C. 20005

Society for Health and Human Values
1311A Dolley Madison Blvd., Suite 3A
McLean, VA 22101

*Primary Source: Reich, 1978